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INTRODUCTION

This manual is the result of the Leonardo da Vinci project titled: **Improving Vocational Education in the Construction Industry Sector with the aim of Identification and Recognition Qualifications in European Union Countries 08-LdV/TOI/02059/013**.

Polish Association of Construction Industry Employers – Poland was the promoter of the project.

Partners of the project: Polish British Construction Partnership Sp. z o. o. – Poland, CREDIJ (Centre regional pour le développement la formation et l'insertion des jeunes) – France, University of Minho – Portugal, Ufficio Scolastico Provinciale di Venezia – Italy, Econometrica Ltd. – Greece, The Chartered Institute of Building – United Kingdom.

PROCONSTR is a project concerning developing an innovative program of vocational training based on eight selected construction professions for graduates from vocational schools, technical secondary schools, and employees who are professionally active and want to increase their skills.

The aim of the job modules is to promote the idea of regular vocational development, support activities leading to implementation of European tools concerning education and vocational training – equalisation of opportunities on European labour markets, intensification of cooperation among companies from construction sectors and social organisations in order to promote vocational development with reference to EQF and ECVET in the Europe.

Moreover the project's challenge is to make participants in the training sessions more aware of the requirement to increase their vocational qualifications with regular training sessions, as well as learning new techniques and technologies that are utilised in the construction industry and language education. Once these skills have been gained it will give them the opportunity of being employed across the European Union.

Unification of essential regulations of vocational qualifications in European Countries might simplify easy transfer of the most modern technologies as well as enabling common usage of knowledge and generating new employees that are able to meet the requirements of contemporary European market.

The nature of the training sessions is directed at men and women, with supporting efforts heading for equal opportunities to access to vocational education and to ensure equality on the labour market, in this case, giving special consideration to the construction branch.

The outcome of the project is an innovative didactic resource for beneficiaries. Eight job modules were created on the basis of data collected and domestic markets available. The didactic materials were created with support of construction companies on national levels.

- **Job Module for Bricklayer**
- **Job Module for Carpenter**

- **Job Module for Plumber**
- **Job Module for Electrician**
- **Job Module for Concrete builder**
- **Job Module for Roofer**
- **Job Module for HVAC worker**
- **Job Module for Plasterer**
- **Module for trainer**

Each job module consists of two parts with the first part being theoretical, including the latest know-how concerning specific trades necessary for employees. The second part consists of training with appropriate examples set out in exercises based on chosen innovative aspects.

The project's creators hope that the final product has a long-term influence which can be utilised successfully in vocational education throughout the European Union. The use of a unified course of vocational training in all countries would result in elimination of formal and informal barriers concerning easy-flow of employees and equalize differences in professional qualification levels.

Equalization of qualifications between European countries would result in the effective exchange of experiences; simplify identification of different types of problems (in less developed countries) and the implementation of preventive means.

Conclusions drawn from the executed project could be used to create new training solutions as well as to prepare vocational education system reforms on a domestic level.

More information on project website: www.proconstr.eu.

INFORMATION ABOUT THE COURSE

Participants should have the following prerequisite knowledge concerning bricklaying prior to attending this course.

The innovations participants will discover on the course are: using thermo-insulating and thin layers and dry joint bricks.

The advantages of this modern technology are:

- self construction ability,
- knowledge about using lighter materials,
- quality work improvement.

The participant will gain knowledge about using new layers and blocks, new skills and competences concerning dealing with these specific materials.

After the course participants will be able to select adequate mortars to specific types of bricks/blocks. Moreover they will be able to apply this technology on your own.

Participants will receive a manual and CD, full of didactic materials like powerpoint, pdf files and vocabulary.

They will be asked to participate in the theoretical lectures (1 day) and practical workshops (2 days) conducted by a vocational trainer. Moreover they will gain knowledge on how to read and use the additional materials included in this course.

Their knowledge will be tested/assessed by a trainer with a set of questions at the end of the course.

After completion of the course they will gain the **PROCONSTR CERTIFICATE**.

PREFACE

The PROCONSTR project is intended for two main groups of construction workers; qualified workers and medium-level technical supervisors. Eight trades covered by the project represent the main professions of a large cubature house building sector as well as the infrastructure sector that constructs office buildings, hotels, commercial, cultural and sport centers, healthcare infrastructure and other public utility buildings. Experts in the fields covered by the project are also crucial for the single-family house building sector. They are equally important in the industrial and road construction sector.

Traditional trades like: concrete builder, carpenter, reinforced concrete builder, mason, roofer, and plumber are currently undergoing a dynamic evolution due to the technical progress in the construction field.

The common use of concrete pumps together with concrete mixers and widespread application of chemical products in construction such as self levelling floor compounds and resin are an important part of the prefabricated reinforced-concrete elements which are used for ceiling construction. Common use of prefabricated reinforcement elements such as meshes and cages has been an important influence on the change from the traditional idea of seperate concrete and reinforced concrete builders. Joining the two trades together creates a more universal trade for the reinforced concrete builder.

The widespread application of formworks and scaffolding used on all types of construction sites has a decisive influence on the ongoing changes in the profile of the carpenter's profession. Similarly, an exceptionally wide range of roof coverings and new methods of assembling makes a crucial impact on the modern definition of the profession of a roofer. Important changes are happening in the field of masonry, where masons are required to have an in-depth knowledge of all types of plasters and glues. The knowledge of an electric fitter has to cover a wide range of low current electric installations. A trade which is currently undergoing particularly dynamic changes due to a huge progress in the field of air conditioning techniques is the HVAC fitter.

Equally, significant progress can be seen in the field of sanitary techniques. A whole range of equipment is available on the market that has not been used before. The use of internal or external materials made of epoxy resins, carbon fibres and other synthetic materials has already exceeded the percentage use of traditional materials. The introduction of different types of plaster, dry walls or other wall elements like cardboards, significantly widens the requirements relating to the trade of a plasterer.

Apart from technological changes that have influenced the profile of vocational training, it is impossible not to mention general requirements which have to be fulfilled by modern construction teams.

These requirements include:

- a significant shortening of the project implementation cycle,
- limiting the area of construction sites, particularly in urban agglomerations,
- the expansion of vertical-building projects,
- the introduction of a top-down method, i.e. a simultaneous construction of both the underground and ground structures,

– carrying out the works in extreme weather conditions, due to the possibility of putting concrete layers at both low and high temperatures.

Nonetheless, health and safety at work is the most important issue, relating to both the dynamics of changes in vocational profiles and strict requirements.

The expansion of the European Community favors the free movement of services in the construction sector. This reinforces the creation of construction companies with international capital. It also creates the need for mobile construction teams, which together with the high quality requirements constitutes an incentive for the unification of qualification of construction workers on the highest level in the whole Union. The aforementioned reasons underline the importance of changes undergoing in the field of construction trades.

A good economic situation for the construction market affects economic development substantially. Demand for residential housing, office space and infrastructural building increases. Orders placed by investors motivate contractors to carry out their jobs and the contractors stimulate enterprises manufacturing building materials to maximize their production capacities; it enables quick completion of construction investments. Consequently, a system enabling stimulation of economies and decrease in the unemployment rate is launched.

When a market presents a demand for a quick and thorough carrying out of investments, the most serious problem there is finding a relevant contractor team consisting of high-class specialists knowing all aspects of a profession and that are trained to the latest methods and technologies used within the construction project, in particular, in fields of their specialization.

Chapter I INTRODUCTION TO BRICLAYER TRADE

A bricklayer is a profession consisting of carrying out bricklayer works, which includes all sorts of bricked structures and related works.

Presently, a bricklayer builds walls, from foundations to the roof. More and more frequently they are employed to build systems consisting of cellular concrete, lime and sand units, ceramic hollow bricks, ceramic bricks and concrete hollow bricks. All of these technologies must be familiar to a bricklayer. Also system tools necessary for construction works are used more frequently rather than the traditional bricklayer's tools. A bricklayer's job, due to a huge progress of materials is easier and more effective.

Range of bricklayer's tasks

The range of tasks carried out by a bricklayer is very wide. The job is classified as a heavy job (physical job) as most tasks are carried out manually. The basic tasks of a bricklayer include: capable of fluent understanding of architectural and construction designs in order to determine material and structure solutions, localization of walls and ceilings to be built, preparation and arrangement of a work position, construction of scaffolding and platforms, fastening of units to transport materials (manual and electric hoists), construction of light wooden structures enabling determination of levels of fragments of a building being carried out, preparation of an adequate mortar by selecting relevant ingredients and mixing them (with correct use of mixing units, concrete mixers, laying stones on a mortar basis, bricks, pre-fabricated elements and bonding) acc. to a construction design, starting from foundations, walls with window holes, door holes, control over brickwork due to use of relevant tools, carrying out of reinforcements, assembly of steel beams as well as reinforcement of window and door lintels, construction and fastening of door and window frames, fastening of window sills, building smoke and ventilation ducts, building complicated arcs and columns, preparation of mortars, liquidation of wall defects, ground coats for plasters, covering ceilings and walls with mortars, float finishing resulting in equal vertical plasterer's area of uniform surface, dry plasters made out of ready-to-use sheet-rocks, and wall preparation for facing/tiling (ceramic plates, stone and marble tiles).

Basic tools used by bricklayers are:

- trowel – used for covering and spreading of a mortar,
- brick hammer – used to break bricks down to tiny elements,
- finishing trowel - used to level mortar,
- spirit level - enabling control over walls,
- meter - measurement of length of a wall,
- brush - to moisten surface of walls before plastering,
- mortar tube – a container for mortar,
- wheel-barrow – to transport a mortar,

- concrete mixer – to mix a mortar,
- ropes, building hoists and cranes to lift building materials from a horizontal area and to store them within the working area.

A bricklayer - studies and training

Bricklaying qualifications are gained in schools and colleges which provide the skills necessary to perform particular construction-related professions. Students obtain theoretical and practical skills over a study period lasting three years. The education program includes general subjects and professional subjects, which amongst others include:

- technology, including basic information on construction materials and methods of carrying out of bricklaying and plastering, an outline of general construction,
- knowledge of construction principles and ways of erecting buildings,
- the rules and norms valid for technical drawing, in order to read and understand technical documentation

To become a professional bricklayer you need to graduate from vocational school and pass a professional exam. Within the regular education system, the following titles confirm held qualifications: a qualified employee, and a foreman, obtained as a result of passing the exam before a national examination commission.

Practical study of the profession takes place in a construction company under instruction . A practical skills instructor is employed by the construction company, usually a foreman or a site manager who has teaching qualifications. The program is carried out during an apprenticeship period which must be agreed by the school.

This education ends with a certificate confirming a level of general education and vocational preparation, acting as a basis for continuing professional development. Employed persons add to their knowledge and skills throughout their career; skills obtained during the work process or due to participation in organised training are confirmed by formal certificates confirming professional qualifications. It is advantageous from an employee's point of view, as it simplifies employment or job change, and also from the employer's point of view as proof of a prospective employees skill levels and potential contribution. The system of apprentice and foreman examinations is legally authorized in Poland, as well as being recognized in the European Union which is important for a uniform labor market and paid emigration process. A characteristic feature of exams is their openness and availability for all groups of candidates, including young graduates, and adults who would like an opportunity to confirm qualifications obtained during professional activity and theoretical training.

The legal basis for apprentice and foreman examinations carried out by exam commissioners appointed by the Chambers of Crafts is constituted by an Act dated 22 March 1989 on Craft (Journal of Acts No. 112, item 979 dated 2002 - uniform text – and Journal of Acts, No. 137, item 1304 dated 2003., and by legislation issued by the Minister of National Education (dated 12 October 2005) on examinations of journeyman and foreman carried out by the chambers of craft's exam commissions (Journal of Acts No. 215, item 1820). The afore-mentioned documents specify detailed

terms and conditions under which the commissions are appointed as well as conditions to be met by a candidate who is allowed to sit journeyman and foreman exams. The journeyman certificate is a basic document confirming professional qualifications and allows the holder to carry out jobs as a qualified employee and take positions requiring these qualifications. After three years at apprentice level, the journeyman can apply to sit the foreman exam.

A foreman's diploma is a document confirming the highest craft's qualifications and enables its holder to run a business activity on its own as well as take executive posts in an enterprise; it is also a document giving authorisations to train juvenile employees (together with a certificate confirming graduation from pedagogical training).

Since Poland joined the European Union, more and more people are doing jobs in the member states using the documents confirming qualifications gained. In accordance with international law, a document which is binding abroad must be certified. In other words, authorisation is required. The treaty on the European Union implemented some general rules, amongst others, regarding the freedom of migration of employees and provision of services as well as a right to do the business activity in all European Union member states. Nevertheless, some obstacles may result in legal restrictions implemented by particular states regarding some jobs and professions, which means that the EU is inhabitant If you want to do a particular job in another Member State, you must comply with principles for doing such activity in a particular state. Thus, it is very significant for holders of documents confirming professional qualifications (issued by chambers of crafts) that the journeyman and foreman certificates observe all formal nature requirements.

Związek Rzemiosła Polskiego ***[Association of Crafts in Poland]*** is authorised to legalise diplomas of journeymen and foremen issued by the chambers of crafts, which are to be presented aboard by their holders.

A bricklayer's job environment

A bricklayer fulfils his/her obligations on a site or inside an building. Working outdoors, a bricklayer is frequently exposed to different climatic conditions which force him/her to wear adequate protective clothing. His/her job is frequently situated at different levels which persuades a bricklayer to be concentrated. Working at high altitudes and lack of basic knowledge of safety at work is the most common reason for accidents on sites. Similarly common reasons are the use of sharp tools and caustic materials, as well as products causing dermatological conditions, and falling objects. Therefore, it is necessary to provide regular safety training on site.

Depending on the size of a site, works are carried out by larger or smaller teams and each bricklayer carries out particular jobs. Low demanding works can be carried out by a single bricklayer supported by an assistant whose task is to mix mortar, and assists with the other elements of a job. The job should be organised in such a manner as to provide freedom for the bricklayer and enable them to have any necessary materials to hand.

Bricklayers coordinate with most specialists working on the site. Bricklaying tasks are carried out during the day. Nevertheless, in exceptional circumstances the job can be carried out in shifts. The jobs are mostly completed during the summer season (jobs on sites or demolitions). The average working day does not exceed 8 – 10 hours. A

bricklayer works in a team and his/her job is supervised by a direct superior and works coordinator/foreman or a site manager. This job is often related to quite frequent and time-consuming travelling to the site from home. Qualified bricklayers may also work abroad.

Psychophysical requirements for the profession

When deciding to carry out the bricklayer job one must give consideration to natural capabilities, features, temperament and skills. The bricklayer job requires patience, accuracy and grit. A series of actions are repeated, however, one is required to concentrate and multitask, as well as needing a resistance to acrophobia, a level of responsibility and discipline as well as the capability to quickly and correctly carry out arithmetic. Most jobs are carried out with the use of manual tools; therefore, professional bricklayers require manual skills. One needs to adjust himself/herself to a work at a constant speed, and show cooperative as well as interpersonal skills. Work on the site requires resistance to long-term physical effects. Due to some works being carried out at a higher altitude or in uncomfortable positions, the person undertaking this job must be in good general health and be characterized by good all-round vision (including depth of field and distance assessment) in order to avoid accidents at work.

A bricklayer requires good spatial awareness, well developed eye-and-motion coordination, perceptiveness and good reflexes. Technical hobbies are helpful since they are usually associated with the ability to use a variety of tools, drawing and reading skills and knowledge of technical tools (mixers, concrete mixers, conveyor belts).

Physical and health requirements

Candidates who are in the bricklayer profession must be characterised by a proper physical and health condition. Hard working conditions mean that it is suitable for strong men who are in good health and characterized by physical strength. Mostly men work as bricklayers. Each candidate is subjected to specialist medical tests – neurological, ophthalmic, laryngological and other general medical tests. On the results of the tests, an industrial sector medicine doctor will issue a certificate confirming fitness to do the job and certifying a lack of reasons to prevent working at altitude and with operating machines. Working bricklayers are subject to medical tests once per two years in order to re-certify their capabilities. Medical causes of failure to pass the tests include: Illnesses of the central nervous system, balance disorders, rapid loss of awareness, regular dizziness and epilepsy, lack of depth vision which prevent assessment of a distance, cardiovascular system illnesses – heart disorders - high blood pressure, diabetes, respiratory system disorders – chronic bronchial and lung disorders e.g. asthma, motor disorders, rheumatism, serious hearing disorders, skin disorders, including a tendency to allergies and sensitization.

Chapter II LEGAL BASIS

In Poland

The bricklaying profession is classified as hazardous. Work is frequently carried out at altitude. There exists a constant hazard of falling objects. Site surroundings are hazardous and uncertain as well. Bricklayers should therefore comply with basic ordinances regulating safety and work hygiene. Additionally, they should comply with a Plan Bezpieczeństwa i Ochrony Zdrowia (Safety and Health Protection Plan), hereinafter referred to as BIOZ, which is prepared by a site manager for each site.

Among basic ordinances (regulations) regarding the Industrial Health and Safety rules there are:

- The Ordinance of the Minister of Labor and Social Policy dated 26 September 1997 on general terms and conditions of the industrial safety and hygiene Journal of Acts, No. 169, item 1650),
- in particular: § 105 to § 110 – Works at altitudes.

Ordinance of the Minister of Infrastructure dated 6 February 2003 on safety and work hygiene during construction works Journal of Acts, 2003, No. 47, item 401).

- Chapter 1 – General provisions.
- Chapter 2 – Conditions of preparation and carrying out of construction works.
- Chapter 8 – Scaffoldings and mobile platforms.
- Chapter 9 – Works at altitude.

In Greece

Under Greek legislation all construction workers' professional activities are considered hazardous. Thus, the profession of the bricklayer is also considered hazardous.

The major dangers are:

- Falls from height,
- Dropped tools or materials,
- Incorrect use of equipment,
- Fire,
- Human error.

The legal framework for bricklayer profession covers the following sections:

1. Rules of preparing and undertaking the job.
2. Health and safety regulations.

Works at heights are covered by:

1. Works at height without scaffolds P.D. 778/80 art. 17.
2. Works on scaffolds P.D.. 778/80 art. 9, 11.

The health and safety regulations can be categorized as following:

- General regulations for health and safety,
- Working at height using scaffolding and mobile platforms,
- Protection from electrical shock,
- Environment protection.

Legislation referred to health and safety regulations:

P.D. 22/12/33 (I.G.G 406 A΄) "On security of workers using ladders".

P.D. 778/80 (I.G.G 193 A΄) "On security measures during building construction".

P.D.1073/81 (I.G.G. 260 A΄) "On security measures whilst performing tasks related to housebuilding and engineering works".

L. 1396 (I.G.S 126 A΄) "Obligations of observance of security measures in structures".

L. 1430/84 (I.G.G. 49 A΄) "Ratification of the 62 International Employment contract, "As regards the safety provisions in the construction industry and resolving directly related issues".

L. 1568/85 (I.G.G. 177 A΄) "Health and safety of workers".

P.D.71/88 (I.G.G. 32 A΄) "Regulation for fire protection of buildings".

M.O. 9087 1004/96 (I.G.G 849 B΄) "Operational protection of outside workers exposed to the risk of ionizing radiation during their activities in controlled areas".

P.D.395/94 (I.G.G 220 A΄) "Minimum safety and health requirements for the use of work equipment by workers at work in compliance with directive 89/655 EU".

P.D. 396/94 (I.G.G 220 A΄) "Minimum safety and health requirements for the use by workers of personal protective equipment at work in compliance with the directive of the Council 89/656/EU".

P.D. 105/95 (I.G.G 67 A΄) "Minimum requirements for safety and health at work in compliance with directive 92/58/EU".

P.D.16/96 (I.G.G 10 A΄) "Minimum safety and health in the workplace in compliance with directive 89/654/EU".

P.D. 17/96 (I.G.G 11 A΄) "Measures to improve safety and health of workers at work in compliance with the instructions 89/391/EU and 91/383/EU".

P.D. 305/96 (I.G.G 212 A΄) "Minimum safety and health requirements at temporary or mobile construction sites in compliance with directive 92/57/EU".

P.D.. 62/98 (I.G.G 67 A΄) "Measures for the protection of young people at work, in compliance with directive 94/33/EK".

M.O. 130646/84 (I.G.G 154 B΄) "Security measures calendar".

Glossary:

L.: Law

P.D.: Presidential Decree

I.G.G.: Issue of Government's Gazette

M.O.: Ministry ordinance

In Italy

In Italy to become a mason, a carpenter or a plasterer one can attend specific training courses that lead to a qualification after compulsory education & training is completed (16 years old). The courses are organized by construction schools, which allow appropriate competencies and skills to enter the labour market.

The vocational training in the construction sector is managed by a national equal education system regulated by the Collective Labour Agreement (art. 90) for construction companies who are members of ANCE – the National Association Construction Builders and various trade unions (FENEAL-UIL, FILCA-CISL, FILLEA-CGIL).

FORMEDIL is the national body for training construction workers and it promotes, manages, and coordinates training and refresher courses in the construction sector. These are organized by the construction schools located across the different Regions and Provinces.

An individual can choose to take up an apprenticeship in a company (which is different according to each profession) and then be hired. Alternatively, an individual can decide to establish his/her own company. According to the Act 443/85 regarding Crafts, if a person wants to establish a company, then he/she must comply with the information and requirements as set out in the act. In particular, the construction company can have a maximum of 10 employees and 5 apprentices. The number can be increased to 14 employees, but these additional workers must be apprentices.

The application should be submitted to the Provincial Register by the local Chamber of Commerce.

Important links:

- FORMEDIL: www.formedil.it,
- ANCE – Associazione Nazionale Costruttori Edili: www.ance.it,

- CEFME – Formazione, ricerca e servizi per l'industria delle costruzioni: www.cefme.it,
- Chamber of Commerce: www.camcom.gov.it.

To find information regarding the legislation in the construction sector, you can visit the following websites:

- Ministry of Infrastructures and Transports: http://www.mit.gov.it/mit/site.php,
- www.edilizia.com,
- www.edilpro.it,
- www.edilportale.com,
- www.edilbox.it.

Legislation on safety at work in the construction sector

The main legislation relating to safety at work is listed below. Several Regions have also issued regional acts.

- Decree President of the Republic No. 547 – 27/04/1955 "Legislation to prevent industrial accidents".
- Decree President of the Republic No. 164 – 07/01/1956 "Legislation to prevent industrial accidents in the construction sector".
- Decree President of the Republic No. 303 – 19/03/1956 "Hygiene at work"
- Legislative Decree No. 494 – 14/08/1996 "Implementation of Directive 92/58/CEE concerning minimum safety and health standards to be applied in the construction sites".
- Legislative Decree No. 277 – 15/08/1991 "Implementation of several EU Directives concerning protection of workers against the risks associated with exposure to chemical and physical agents".
- Legislative Decree No. 493 – 14/08/1996 "Implementation of Directive 92/58/CEE concerning the minimum standards for safety signs at work".
- Ministerial Decree 10/03/1998 "Safety criteria for fire prevention and emergencies at work".
- Legislative Decree No. 235 – 08/07/2003 "Implementation of Directive 2001/45/CE concerning minimum safety and health standards when using equipment at work".
- ISPESL guidelines to identify and use protection devices to prevent falls.

Links:

- Ministry of Labour: www.lavoro.gov.it,

- Ministry of Infrastructures and Transports: http://www.mit.gov.it/mit/site.php,
- ISPESL: www.ispesl.it.

In the United Kingdom

Generally, the laws governing health and safety relate to all construction activities and trades (including design) and are not industry specific. There are several Acts and Regulations.

Some of the principal Acts which deal with health, safety and welfare in construction are as follows:

- Health and Safety at Work etc. Act 1974,
- Mines and Quarries Act 1954,
- Factories Act 1961,
- Offices, Shops and Railways Premises Act 1963,
- Employers Liability Acts – various,
- Control of Pollution Act 1989,
- Highway Act 1980,
- New Roads and Streetworks Act 1991,
- Corporate Manslaughter and Corporate Homiside Act 2007.

The fundamental Act governing health and safety in construction is the Health and safety at Work etc. Act 1974. The principal regulations of this Act which affect design and construction, are:

- Management of Health and Safety at Work Regulations 1999 amended 2006,
- Construction (Design and Management) Regulations 2007 (known as the CDM Regulations),
- The Work at Height Regulations 2005 amended 2007.

Some other related regulations and guides are:

- Site Waste Management Plans Regulations 2008,
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 1995,
- The Control of Major Accident Hazards Regulations 1999 (COMAH) amended 2005,
- The Chemicals (Hazard Information and Packaging for Supply) Regulations 2003 (CHIP 3),
- The Health and Safety (Display Screen Equipment) Regulations 1992,
- COSHH (Control of Substances Hazardous to Health) Regulations 2002: Provision and Use of Work Equipment Regulations (PUWER 98),

- Lifting Operations and Lifting Equipment Regulations (LOLER 98),
- Personal Protective Equipment at Work Regulations 1992,
- Signposts to the Health and Safety (Safety, Signs and Signals) Regulations 1996,
- Control of Asbestos Regulations 2006.

Some of the principal Acts and Regulations which deal with environment, are as follows:

- The Environmental Protection Act 1990,
- Environment Act 1995,
- The Clean Air Act 1993,
- Radioactive Substances Act 1993,
- The Control of Asbestos Regulations 2006,
- The Ionising Radiation Regulation 1999,
- The Control of Lead at Work Regulations 2002.

The regulatory organisations are (according to the Environment Act 1995):

- The Environment Agency (in England and Wales),
- The Scottish Environmental Protection Agency (in Scotland).

In Portugal

Labour Law: The Labour Code in Portugal is regulated by Law n. 7/2009 of 12th February. Further information regarding construction works contracts may be found in the Collective Work Contracts in the Construction Sector (CCT, Contratos Colectivos de Trabalho para o Sector da Construção) published by the Ministry for Labour and Social Solidarity in the Employment and Work Bulletin (Boletim do Trabalho e Emprego) n. 12 of 29th March 2009.

Standards for the Small and Middle-size Enterprises (SME): There are no specific regulations for SME. For the construction and real-estate companies there is a regulating entity (the Construction and Real Estate Institute -in PT, Instituto da Construção e do Imobiliário, INCI) and specific regulations concerning the admission and practice activity, namely:

- Decree-law n. 12/2004 of 9th January 2004 establishes the legal framework for the admission to and permanency in the construction activity,
- Decree n. 19/2004 of 10th January 2004 establishes the categories and subcategories related to the construction activity,
- Decree n. 21/2010 of 11th January 2010 establishes the value of the construction works according to the qualification categories of the building permit for 2010,
- Decree-law n. 211/2004 of 20th August 2004 regulates the real estate activity.

Basics of construction standards: General Regulations of Urban Buildings (in PT: Regulamento Geral de Edificações Urbanas, RGEU) approved by Decree-law n. 38382 of 7th August 1951 (altered by Decree n. 38888 of 29th August 1952 and further revisions). A new version is foreseen to be published soon (in PT: RGE).

Basics of construction Works Contract: For general contracts, the Civil Code approved by Decree-law n. 47344/66 of 25th November 1966 (1st version) and for public contracts, the New National Public Procurement Code approved by Decree-Law nº 18/2008 of 29th January 2008 (modified by Decree-law n. 278/2009 of 2nd October and Decree-law n. 223/2009 of 11th September).

Health, Safety and Welfare Regulations: Decree 41821 of 11th August 1958 establishes the work safety regulation for building construction; Decree-law 441/91 of 14th November 1991 establishes the general principles for the promotion of Health, Hygiene & Safety at work (transposes Directive n.º 89/391/CEE of 12th June); Decree-law 273/2003 of 29th October revises the legal framework on Health and Safety conditions in the construction site (incorporating the minimum prescriptions required for temporary/mobile construction sites established by the Directive n.º 92/57/CEE of 24 June).

In France

1- Basic concepts: standards, DTU, Technical advice (Avis Techniques).

1.1. Standards: see: Standards and European directives (source: AFNOR)

French approved standards are mandatory for State and local government funded contracts. They are also recommended for privately funded contracts.

1.2. DTUs (Unified Technical Documents) are documents that contain technical rules relating to the execution of building works using traditional techniques. They are recognized and approved by construction professionals. They also provide a reference point for insurance experts and the courts. Failure to comply with DTUs may lead to the invalidation of warranties offered by insurance providers. DTUs specify standards for traditional construction methods and are considered the epitome of reference texts. They are intended for relevant state bodies as well as contractors (whether architects or general contractors), owners and other experts. They are authored by a committee advising on technical texts.

1.3. **Technical advice** is advice from a committee of experts specialising in relevant trades and the expected behaviours of materials, components or processes. They define the characteristics of any materials, components or processes involved, and give advice on their durability and suitability for use and how they comply with regulations.

2 - DTU

2.1. Status of DTU

The DTUs are established by a body created in 1958, the "**Groupe de Coordination des Textes Techniques** / **Groupe DTU"** (the "Coordinating Group of Technical Texts or Group DTU").

In 1990, this group became the "**Commission Générale de Normalisation du Bâtiment/DTU** "(the General Committee for the Standardisation of Building / DTU) in

order to integrate it into the French official system, which was necessary to comply with European technical harmonization (Eurocodes)

This means that the DTUs have become standards. The transformation took place gradually through the regulatory procedures that govern standardsation.

As a result, the DTU(s) now have one of the following statuses:

Approved French standard (**Norme française homologuée):** this is a standard which has received official government approval, its technical value is recognized, and it plays an important role in the construction system,

Experimental standard (Norme expérimentale): which is undergoes a period of probation before being confirmed or amended to become a certified French standard,

Documentation booklet (Fascicule de documentation) : standard documents, essentially informative documents,

DTU: the original form of the documents. Not part of the official standard system. In most cases DTU status is temporarily held in anticipation of its integration into the official standard system.

2.2. Private works

DTU is implemented following an agreement between the "maitre d'ouvrage" and the construction contractor. A DTU only commits the signatories, giving it a sense of obligation of contract.

Some standards and some French registered DTUs can be mandatorily enforced by regulatory decisions (often when safety-related).

2.3. Public works

The amended Decree of January 26, 1984 governs the application of French standards in contracts approved by the government, local authorities, public bodies etc., except in special cases as listed in the decree.

2.4. Composition of a DTU

A DTU may consist of the following documents:

Technical specification clauses booklet (**cahier des clauses techniques**: **CCT**) which sets out the requirements for the selection and use of materials,

Specification of special provisions booklet (**cahier des clauses spéciales**: **CCS**) which defines performance limits and obligations to other trades,

Rules for calculating the structural design.

All these documents are contractual documents and must be adhered to. There are also other documents, such as memos and selection guides, which are useful for structural designs that are not intended to be imposed by contract.

Like ISO standards, the DTU(s) must be bought. They can be found on the CSTB website: http://boutique.cstb.fr/

(CSTB = centre scientifique et technique du bâtiment: scientific and technical center for construction)

DTUs and other required documents are listed on the CSTB website. There are specific DTUs for each profession : (see example for roofers on the next page)

http://boutique.cstb.fr/dyn/cstb/Upload/Fichiers/Liste_0310.pdf

HEALTH AND SAFETY

On building sites required by the coordinator of safety to have a general plan of coordination, the companies involved must create a **PPSPS** (Particular plan of safety and protection of health) valid for **all workers** on the building-site

PPSPS: Particular plan of safety and protection of health

Contents of the PPSPS

1. The name and address of the company, the address of the building site, the name and qualifications of the person in charge of the work.
2. The description of work and methods of work showing the company's specific risks and chosen means of prevention, taking into account any environmental constraints. Work involving risks of interference arising from co-activity with other companies, mutual risks and the prevention methods available.
3. Procedures for observing any measures of general coordination defined by the coordinator.
4. Rules for hygiene and for workers' areas as laid out in the general coordination plan .
5. First aid organization of the company; including the medical equipment available, first-aiders and on site, measures for evacuating any injured persons, according to the general coordination plan.

The descriptive part of the plan is the most important; it must be accompanied by a detailed analysis of the risks related to procedures, materials, devices and installations, the use of dangerous substances or preparations, and to circulation on site.

Plans or sketches drawn for the building site can effectively replace text. Photocopies of documents are to be avoided in general , except for private copies.

The plan can evolve and change, so it is always possible to modify any of the given procedures or preventive measures if the incurred risks are decreased or if the preventive measures give an equivalent guarantee.

Texts referring to the **labor regulation:**

Principle of prevention articles R 230-1 with R 234-23,

General plan of coordination R 238-20 to R 238-36.

texts **for the prevention and the safety of the worker**s:

N° circular 6 DRT of April 18th, 2002 of the ministry for employment and solidarity,

Law N° 91-1414 of December 31st, 1991 published with the OJ N°5 of January 7th, 1992,

European directive 89/391/CEE of June 12th, 1989,

Decree 2001-1016 of November 5th, 2001 relating to the single document published in the 258 Olympics of the 11/7/01 page 17523.

Chapter III A NEW CONTEXT

From the description of the bricklayer job it shows that the range of tasks is very wide.

However, in practice it turns out that this range is much wider and that a bricklayer is required to have a lot of skills. Generally, bricklayers frequently do reinforcement and plastering jobs. Moreover, they often build shell-state buildings. As a result requirements for bricklayers, in terms of knowledge and skills are quite comprehensive and are running parallel to the rapid development of construction technologies. Bricklayers are required to self-educate and regularly update and extend their qualifications by undertaking professional training. Due to this fact the jobs related to the bricklayer position become simpler and efficiency of bricklayers increases. One needs to remember that the number and quality of orders for works depend on the knowledge and skills of the worker doing a bricklayer's jobs. Market has its rights.

Care for natural environment

Bricklayers belong to the category of construction employees working on the site for almost the entire period to completion. Therefore they should pay attention to degradation of natural environment and prevent it. In order to ensure that the site does not disrupt the natural environment each worker needs to take responsibility for tidiness, waste disposal and recycling, and the correct storage of building materials. He/she needs to consider the correct protection of trees near the site. The quality of the technical equipment used on the site is significant as well, with particular regard to the minimization of noise pollution.

Technological evolution includes use of the new materials as well. It is necessary to ensure that the materials used for bricklayer's jobs do not pose a hazard for humans. A very significant issue is the re-use of recycled materials. It is necessary to remember that the choice of materials for walls is based on the thermal conductivity of a material. Solid performance of bricklaying works is very significant issue as well. Better thermal insulation of a wall means less consumption of energy and a lower emission of CO2 to the atmosphere.

Chapter IV DESCRIPTION OF NEW SOLUTION

Learn your job quickly and be efficient

The building market suffers from the tiny number of qualified employees doing bricklayer's jobs. It is affected by many factors, mostly, by hard and difficult working conditions, seasonal employment and remuneration which does not always correspond to the effort expended. However, a quickly developing market forces contractors to increase the number of appropriately qualified employees. This causes some difficulties since the number of people having adequate skills, knowledge and who have undertaken professional training is low. In the light of requirements, provisions and market situation, simple technologies which shorten the time necessary to complete an investment, are becoming very popular.

This situation has forced building material manufacturers to invent products which enable the performance of basic bricklayer's work –particularly in the single-family housebuilding sector – by unqualified employees with minimal training. An example of such technology – in terms of basic elements of a building (walls) – there is use of cellular concrete which, with use of a thin joints, enables quick wall erection. Such technology does not require a long-term experience from a contractor. The opportunity to learn about this technology during short-term training which can be provided by a site manager is a great solution these days. Subsequent observance of the sequence of particular works and use of basic tools brings the opportunity to carry out bricklayer's jobs without mistakes. This is advantageous for both an investor and the contractor.

Innovative technologies and materials

In the light of requirements, provisions and the market situation, simple technologies, which shorten the time necessary to complete an investment, are very popular. One of them there is use of modern mortars. In order to prove advantages and innovativeness of some technologies, a short presentation of the available solutions is necessary.

Masonry mortars

Presently the following masonry mortars are used:

- casual,
- thin-layer,
- light (insulating).

Casual mortars

Among these mortars there are cement-based or cement & lime mortars which, after applying, are from 6 to 15 metre thick. Since such mortars are characterized by poor insulation parameters they are used in walls which are subsequently insulated and to erect walls indoors. Thickly-applied joint may be applied in case of erection of elements which does not have to be too accurate (e.g. concrete blocks, ceramic elements). Casual mortars are treated as traditional mortars because they have been used for hundreds of

years (wall elements highly accurate, which may by erected due to other mortars, are rather new invention).

In order to prepare a traditional mortar on site recipes can be used acc. to approximate contents or with dry mixtures which are mixed with water. Mortars mixed during the erection process on site have different parameters since the selection of ingredients is approximate – frequently spades are used to measure them.

In order to erect walls when using casual mortars, one needs some experience and bricklayer's skills. Despite the disadvantages there are advocates of this process.

Adhesive mortars

Another modern bricklaying form is bricklaying using so called thin-layer adhesive mortars. Development of these mortars occurred in as soon as the production and availability of accurate (in terms of dimensions) wall elements. A thin-layer mortar is a mortar 1 to 3 mm thick (usually 1 mm). This type of mortar suits elements whose tolerance (in terms of dimensions) is equal to 1 mm. This sort of criteria is required by elements made of cellular concrete, silicate elements and polished ceramic hollow bricks. It should be mentioned that some manufacturers do not provide high accuracy elements.

Thin-layer mortars suit single-layer walls best. Due to the fact that the joint is thin, the impact of joints on thermal insulation is negligible (it does not affect the insulation of the entire wall).

Thin-layer mortars have other advantages. In order to apply these sorts of mortars simple trowels are adjusted to the width of blocks, with ‘teeth’ which enable application of appropriately thick mortar. In spite of appearances, erection with thin-layer mortar is simpler than bricklaying using casual mortars. To build these, one does not have to be a bricklayer, as proved by Habitat for Humanity, where volunteers - who have no bricklaying experience –erect walls in this way after a short training session. There are also investors who build their houses by themselves.

Adhesive mortars come in the form of dry mixtures on a base of cement which are ready-to-use after mixing them with water. To prepare the mortar a mixer arm inserted on a slowly-rotating drilling machine is used.

Also walls of elements profiled due to tongue and groove method can be erected on the thin-layer joint. Then, the head joints are not filled. It is a great advantage which accelerates completion of works.

An additional advantage is the low level of technological humidity during the erection process. In order to illustrate the scale for a middle-size building, the table below lists some data.

Table 1

Type of a wall	Wall thickness [cm]	Use of a mortar in kg – dry mixture	Quantity of water per 1 kg of dry mixture [liter]	Quantity of water per 1m^2 of a wall [liter]	Wall area [m^2]	Quantity of water in a building (in walls) [liter]
A wall made of cellular concrete with a thin joint	24	3	0,25	0,75	300	225
A wall made of cellular concrete with a thin joint	42	5,3	0,25	1,325	300	398
A wall made of cellular concrete with a casual mortar	24	25	0,14	3,5	300	1050
Tiny elements, e.g. ceramic ones with casual mortar	24	50	0,14	7	300	2100

It seems clear that with the use of a casual mortar, compared to thin-layer one, water use is 5 times lower.

Thermo insulating mortars

To erect single-layer walls light mortars can be used as well. Light mortars are recognized to be thermo-insulating. They are mixed with foamed polystyrene, pearl stone or expanded clay.

Thermo-insulating mortars may be prepared with ready-to-use mixtures packed in tight bags which are mixed with water. Bricklaying by using thermo-insulating mortars is not particularly different from a classic erection process with using traditional mortars.

Despite the name, the thermo-insulation levels of these mortars is two times worse than the insulation provided by bricked elements. On top of this, the addition of pearl stone, granulated foamed polystyrene or expanded clay means such mortars are more expensive than e.g. thin-layer mortars. This is why this sort of mortar is rarely used and they are slowly disappearing from the market. Although this is the only correct manner

of bricklaying where there are inaccurate elements, these mortars enable the preservation of quite good parameters of thermal insulation of the entire wall.

Development of mortars

So-called foam adhesives are currently in development. Manufacturers purposefully use the ‘mortar’ name in relation to these products but the products are actually based on polyurethane. This is to associate them with their intended use, i.e. bricklaying (a mortar is a mixture on the cement base). Foam mortars in cans do simplify the bricklaying process but only under some conditions and with the use of relevant elements. At this moment this type of mortars is being tested in terms of their durability, behavior under dynamic loads, and when affected by high temperature and fire.

USE OF NEW TECHNOLOGIES

Wall element – this is essential

The building of a wall's element is substantial. No matter whether this is a block or a hollow trick, apart from the purely technical parameters of material, the accuracy and shape are significant.

Manufacture of accurate wall elements requires accurate bricklaying. If a wall’s elements have centre-matched profiled surfaces (Picture 1), then face joints are not filled (Picture 2). Profiled coupling hand grips are to simplify the transport of blocks.

Picture 1: Centre-matched block and groves with coupling hand grip.

Picture 2: When erecting walls of profiled blocks the head joints are not filled with a mortar.

Bricklaying manner

Depending on a used wall’s elements one may carry out casual or thin-layer mortar. A casual mortar is related to inaccurate traditional wall’s elements. With a mortar up to

15 mm thick it is possible to level unevenness of a wall. Thin-layer mortar means a higher level of performance. In such case one may use only accurate elements and relevant tools. This is the basis for correct building.

If one disposes with profiled elements then the head joints are not filled with a mortar. This can be a great advantage which accelerates completion of works. This also means less technological humidity in a building at the stage of construction.

Picture 3: Erection with use of an adhesive means less humidity in a building.

System building – quickly and simply

Another development stage of the building process is posed by building with cellular concrete. Opportunities produced by the use of a modern material like cellular concrete are great. Bricklaying is carried out with using simple manual tools and it is very simple. Preferably, one should use an entire system which means blocks, masonry mortar, elements of lintel, U profiles, tiles, tools and other elements. Cellular concrete, due to its excellent properties, is a great material to erect single and multi-layer walls. Optimally it matches the most significant properties which should characterize a wall: Resistance to squeezing, thermal insulation and fire resistance. Additionally, it is characterized by a low volume mass which means that it may be used for the manufacture of elements (e.g. blocks) of large dimensions, whilst keeping all the principles of ergonomics.

Additionally, the system elements which means selection of elements adjusted to each other brings high opportunity for complex construction of a building. This improves safety and is a great simplification for investors, contractors and designers.

Such a system consists of many elements matching each other, such as: blocks, tiles, profiles, lintels and supplementing elements. All elements are 240 mm high and are characterized by the same dimensional tolerance (1 mm). The system also consists of the tools necessary to lay bricks with the use of a thin joint. The system means a lot of opportunities for erection and adjustment to individual needs and the preferences of investors, ambitions of designers and contractors. It enables erection of any of buildings acc. to detailed requirements laid down by investors and architects. Ergonomic elements of the system enable quick erection compared to other technologies. Ease of cutting, blocks' profiles (tongues and grooves), and hand grips as well as opportunity to use the thin joints comprise the unquestionable advantages of the system.

Picture 4: Erection of a building with use of a system.

Picture 5: System without limits.

Due to the system it is possible to construct any type of building:

- multi-family buildings
- single-family buildings
- industrial buildings
- commercial buildings
- other.

The system elements can be used to construct walls of a basement, external carrying walls as well as internal and partition walls. Blocks are proven when it comes to filling external and internal walls. They greatly enhance the arrangement of an area inside a building, e.g. using tiles to brick fireplace housings, bath tubes, cabinets and other structures.

Single and multi-layer walls – one system, many opportunities

Cellular concrete may be used to erect single layer walls without insulation or multi-layer ones. To construct a single-layer wall blocks of large tolerance are used for performance. Due to this fact one may erect by using a thin joint while the joint's affection on insulation rate is negligible. Blocks may be equipped with a profiled

tongues and grooves as well as hand grips. In order to couple them one needs to use a thin-layer adhesive mortar to erect walls with thin joints.

A single-layer wall is a barrier which is constructed easily and quickly. This is a simpler solution than a multi-layer wall. In case of a single-layer wall the load carrying and insulation functions (thermal insulation, fire and acoustic insulation) are provided by a single layer. The insulation parameters of the blocks are good enough that they do not need to be insulated. Light types may provide coefficient at the level U=0,25 W/m^{2}K. Such a coefficient is obtained for multi-layer walls when the insulation layer is 12-15cm thick. In the case of such solutions it is important to use system solutions which enforce correct carrying out of all details appearing in a building (in terms of structure and physics of a building). Therefore, apart from blocks and thin-layer masonry mortar there are also tiles, lintels, U profiles and other system elements – Picture 6:

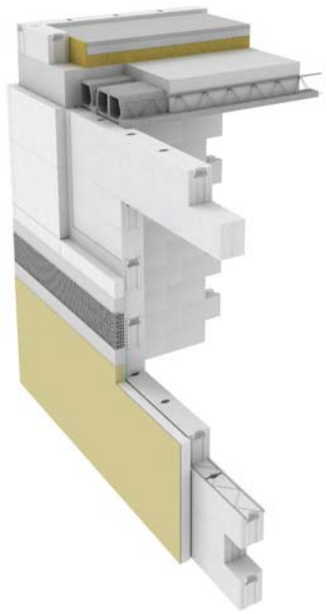
Picture 6: A single – layer wall means significant simplification of a wall's structure.

Multi-layer wall made of cellular concrete blocks

A multi-layer wall is a barrier consisting of a load carrying layer and an insulation layer, and – potentially – a face layer. Double-layer walls are the most frequently used – consisting of a load carrying layer and insulation made of mineral wool or foamed

polystyrene (Picture 7). Triple-layer walls are also built. In this case the face layer is usually made of face bricks.

The wide variety of classes of density of blocks enables optimal selection of elements which can be adjusted to an investor's requirements. Contractors and investors appreciate this solution since it provides the opportunity for quick and simple erection.



Picture 7: Single-layer wall with insulation.

Both methods pose good solutions. Each of them has its advantages and disadvantages. Well insulated wall is erected with different methods.

With both solutions it is important to exercise due diligence and observe a few principles in terms of performance. This enables the optimal use of the advantages of cellular concrete, as well as accelerating bricklaying works and eliminating mistakes.

Wall bricklaying

Walls in the building meet a series of important functions, they transfer loading, insulate thermally and acoustically, and protect from humidity. These are significant elements of a building.

As was mentioned, there are many methods of erecting walls. They can be single-layer, single-layer with insulation, or triple-layer with facing. All solutions must result in the correct construction of such an integral part of a building.

Bricklayer's works may be organized in any way and each contractor has its own style of work arrangement. Three-person teams work well. Two people erect walls and the third person prepares mortar, brings material and cuts blocks. If there is an electric band-sawing machine on the site, those responsible for cutting blocks and mortar preparation may serve a higher number of wall erectors.

Tools for a good beginning

A 'visit card' for each contractor, there are referential objects and investors' opinions. Professionalism of a contractor is also proved by – among others –the tools used. They should be selected properly, complete and efficient. Relevant tools used correctly simplify completion of works, accelerate the job and enable proper performance.

This concerns all materials including the cellular concrete. To erect using cellular concrete and maintain a thin joint one needs to have basic bricklayer's tools. This cannot be achieved without the use of tools.

Bricklayer's team must be equipped with trowel, pace and finishing trowel, rubber hammer and a saw to cut the cellular concrete. The set may be supplemented by a professional band-saw to accelerate completion time. To erect using a thin joint one needs the following special tools:

Mixing unit

- The mixing unit is used to mix adhesive mortar for thin joints. It is a special shape in order to prevent aeration of the mixture. It is fastened on a slowly-rotating drill. The mixing unit is not necessary when working with a thin joint since the mortar is frequently prepared in a concrete mixer.

Picture 8: Mixing unit.

Set of trowels

- To erect using a thin joint one needs to use width-adjusted trowels. In the case of walls erected with thin joints the layer of the mortar should be 1 to 3 mm thick. Due to the specially profiled teeth of a trowel, a mortar layer is always of relevant thickness. The shape of the side walls of a trowel means that laying the mortar does not result in pouring it beyond blocks. Consequently, floating the mortar is very simple. Using a 'comb' for glaze is prohibited to float the mortar.

Picture 9: Trowel used to erect with thin joints.

- To erect walls using casual mortar a traditional trowel is used.

Rubber-face hammer

- To stabilize a block on a moat a rubber hammer is necessary. This type of hammer does not cause damage to the material when it is used. This hammer can be used when erecting walls with a thin and casual joint.

Picture 10: Rubber-face hammer.

Finishing trowel and plane

- They are used to polish and level potential unevenness of the upper area of blocks. A finishing trowel (Picture 11) is used to polish blocks of density class 400 kg/m^3, whereby the pane is used for classes of density 500 kg/m^3 and larger.

Picture 11: Finishing trowel.

- When erecting walls with a thin joint, use of the plane (Picture 12) and finishing trowel is necessary but they are not necessary when using a casual joint.

Picture 12: Grinding plane.

Widia saw

- All elements made of cellular concrete may be easily and quickly cut till they are the desired shape. A manual widia saw is used (Picture 13). This type of saw can be used when erecting walls with a thin and casual joint.

Picture 13: Saw.

Angle guide

- This is helpful when cutting with a widia saw. It simplifies maintenance of Wright angles and cutting angle 45°. Since there is always a need for cutting a block it is very useful. The angle guide – Picture 14.

Picture 14: Angle guide.

- As is clear, all necessary tools must be included within the basic set used for erection of walls of cellular concrete with a thin joint. The set may be supplemented, e.g. by a professional band-saw which cuts the time necessary to complete bricklaying works. This type of a saw is

useful when a contractor erects a lot. Situation, when Works on particular sites are coordinated is optimal. Then the band-saw is used.

Band-saw

- Electric or table band-saws are designed for accurate and quick cutting of a lot of complicated shapes. This tool accelerates erection of walls significantly. It is recommended for contractors serving a few sites. When bricklaying works are coordinated between several sites it can be used optimally.

Picture 15: Table band-saw.

- Apart from system tools used to erect walls of cellular concrete some other commonly used tools are necessary.

Drill

- The drill is used to mix adhesive mortar for thin joints. A drill with a large power rating is recommended.

Spirit level

- A basic tool showing whether a surface is level, either horizontally or vertically. The best spirit levels are 80 to 120 cm long.

Inch-rule

- Basic measurement tool of a contractor.

Tape or laser range-finder

- These are measuring tools, in particular over larger distances. It is an accurate tool for carrying additional and more complicated measuring.

Leveling instrument with a stand

- Tools to control the correct situation of layers of blocks and other elements of a building.

Masonry string

- Used to set out straight lines of erected walls.

Brush

- Necessary after polishing of blocks for removal of dust. Failure to carry out this simple action may result in lack of adhesion of the mortar.

Summarizing, basic tools are not complicated. However, a complete set of tools is necessary. Dependably on the composition of the bricklaying team some tools must be duplicated. One needs to remember tools are a basic requirement for proper performance on the job.

Works preceding bricklaying

When the foundation walls are ready it is time to begin the above ground part of a building. However, before the erection of walls, some important procedures must be completed.

Before bricklaying it is necessary to use a leveling instrument or a hose with water to control the level of upper layer of foundation walls. The highest and the lowest point of foundations must be checked. Differences of levels must be leveled with use of cement mortar layer. This is a very significant action since accurate leveling has an impact on the accuracy and tempo of subsequent works.

Picture 16: Control of level of foundation walls.

Horizontal insulation of the ground floor walls

Horizontal insulation is a very significant element of a building's structure. It protects a house from moisture, which may occur on a foundation wall. This type of insulation must be done accurately. Potential subsequent corrections are very cost-consuming and their execution is very complicated.

Horizontal insulation may be carried out in two ways: using an insulation foil or a torch-on membrane. Both solutions are described below.

Insulation with foil

Insulation foil used for horizontal insulating of walls is a foil characterized by special rough areas. Due to this solution no slippery area exists. The foil is laid down on a layer of cement mortar which levels differences, covering irregularities of the upper area of the foundation wall, and protecting the foil from damage. A cement mortar is poured on the foil. It protects the foil and poses a base course for the first-layer blocks.

Picture 17: Insulating the ground floor's walls using insulation foil.

Insulation with a torch-on membrane

A second and equally valid solution for vertical insulation is torch-on membrane. Before a layer of torch-on membrane is laid down it is necessary to coat the upper area of the foundation wall with insulation coating. It (the coat) penetrates the foundation blocks and increases the torch-on membrane adhesiveness. Strips of torch-on membrane are unrolled on this coat. Then the torch-on membrane is covered with cement mortar, on which first layer of blocks is laid down.

Picture 18: Insulation with a torch-on membrane.

In case of both solutions it is important to have the layer of foil and torch-on membrane wider than the wall by at least 5 cm.

Erection of the first layer

Before starting, the manner of the base course erection should be considered. In most cases the face of the ground wall projects beyond the face of the foundation walls. In this way the base course is constructed. The base course must be at least 30 cm tall. This gives a natural protection of the ground floor's walls from precipitation, due to the apron around a building.

Apart from the height of the course base, the projection of the ground floor beyond the face of the foundation wall is significant. It is important to keep the overhang of the ground floor wall above the foundation wall (up to 1/3 of thickness of the ground wall's

block). In case of a wall projected beyond the face from both sides, the sum of overhangs should not exceed 1/3 of the thickness of the ground floor's wall.

Erection of walls starts by laying blocks in the corners of a building. The first layer is erected with a cement mortar applied to a casual trowel.

Cement mortar may be prepared directly on the site, in a concrete mixer. The ratio of the cement to sand is 1:3. Ready-to-use cement mortars may be used. They must be prepared acc. to a manufacturer's guidelines.

Picture 19: Erection of the first layer of blocks on a cement mortar.

Blocks are laid on the mortar in such a way as to keep tongues out. Tongues projecting from a wall's plane may be ground off and the hand grip may be filled during plastering works. Alternative laying of blocks with grooves out is also correct but requires the filling of free groove space with a plastering preparation.

A block must be stabilized by striking it with a rubber hammer a few times. This action assures good contact between the block and mortar and enables correct situating of a block. Then it should be leveled with a spirit level.

Picture 20: Stabilization and correction of a block - casual mortar.

In fact, the first layer of blocks is erected with cement mortar but in order to complete the first layer some adhesive mortar is required for the thin joints. The strength parameters and fixing parameters of the mortar are adjusted to the wall's elements.

Preparation of the mortar is very simple, mixing dry mixture and water is perfectly adequate.

Adhesive mortar for Thin Joints is a dry mixture of cement, lime, aggregate and modifying substances. Its advantages are the ease and speed of application, as well as its great adhesive properties on ungrounded bases of cellular concrete, silicate or brick.

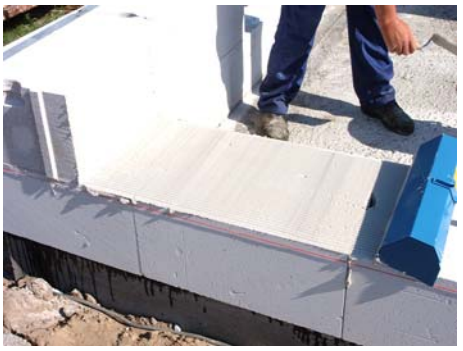
For a bricklayer, use of ready thin-layer mortar is a considerable simplification and has safety advantages – namely, that it is difficult to make a mistake. After adding the

appropriate amount of water one obtains a well-mixed mixture of technical parameters declared by the manufacturer.

The mortar must be mixed with a mixing unit fastened in a slowly-rotating drill. The mixing unit has a special shape which means that the mortar is not aerated when it is mixed. A ready-for-use mortar should be of uniform consistency - similar to a dense cream. It must be used within 1 – 3 hours from the time of mixing - dependably on weather conditions. Dense mortar must not be re-diluted with water!

Application of the mortar with a trowel is very simple. Appropriately profiled 'teeth' and trowel that is width-adjusted to the wall's elements almost guarantees correctly applied mortar. Practically it is possible to make a mistake at this stage, but the operation should be clean, easy and quick.

Erecting the second block in a corner requires thin-layer mortar. Since the side area of a block is not profiled one needs to apply a thin-layer mortar on the block which is to be added. For this purpose a trowel of appropriate width must be used. Due to the specially profiled 'teeth' of a trowel, mortar of relevant thickness is always applied on a block.



Picture 21: Application of thin-layer mortar on the non-profiled part of a block.

The procedure is the same when erecting the other corners. It is necessary to erect them at the same level. This should be controlled using a leveling instrument. Consideration should also be given to the orientation of corners in relation to shaping. Neighboring corners should be erected in a system allowing the same direction of tongues and grooves.

When all corners are ready and their level has been controlled as well as the projection beyond the face of a wall, a rope may be spread between corners to set out the line of the external wall.

Then, one proceeds as with the first layer. Hand grips enable comfortable transportation of a block and its' accurate placing. The first layer of blocks is erected on cement mortar. The requirement to stabilise (using the hammer) and level (using the spirit level) each block should not be forgotten.

The system of tongues and grooves in blocks provides a significant advantage. Vertical spaces between blocks are not filled with mortar. Blocks are just added and they match each other like "Lego" bricks. Due to this the erection process is quick, clean and effective.

Picture 22: Coupling of blocks using tongues and grooves.

When the first layer is finishing there comes a point when the last block must be added.

Picture 23: There is one more block to be erected but its dimensions deviate from standard ones.

In most cases it needs to be cut. At first it is necessary to measure the empty space to get its' dimensions. Then the block must be cut on the tongue side; grooves must be left intact. It is easier to adjust such a block to the empty space when there are tongues at one side and grooves on the other. The block can be cut with either a manual saw or a band-saw. If cutting manually, the use of a guide is recommended to obtain a perpendicular cutting plane. Before inserting the block in the wall the size in relation to the empty space should be checked. A block that is too small may not be laid. In this case, where the block is too short a new one must be cut. Since there are no tongues – as they were cut off –a thin-layer mortar should be applied. For this purpose use a trowel of appropriate width. The mortar layer should be 1 – 3 mm thick.

Picture 24: Application of thin-layer mortar on the cut area of a block.

Now the last block can be inserted into the wall's layer. It is stabilized with a rubber hammer. Its level in relation to other blocks must be controlled.

Picture 25: Erection of the last block.

When building external walls one should also consider the erection of internal load carrying walls. Therefore, after the completion of the first layer of external walls, blocks of internal carrying walls should be laid.

At first – this should be the blocks adhering to the external walls. As this is the first layer, the blocks may be erected using a cement mortar. The mortar should also be applied to the contact area of the internal and external wall's blocks.

Other operations are the same as the erection of the external walls. A block is laid down and stabilized with use of a hammer. Again, the orientation and direction of tongues and grooves should be considered. This will simplify the erection of walls and minimize the number of blocks to be cut.

Erection of other layers

Before erection of each subsequent layer, a base must be prepared. Firstly, any unevenness must be ground down with a finishing trowel. This is a very important operation when erecting with a thin joint. Even tiny unevenness may mean that is impossible to obtain a thin joint (1 to 3 mm).

Blocks of cellular concrete are easily ground and don't require great strength.

Picture 26: Grinding down unevenness with a finishing trowel.

After grinding, it is necessary to brush the dust off. Dust could cause the mortar to adhere inadequately and result in subsequent layers of blocks failing to adhere.

Each subsequent layer begins with the erection of corners. At first a trowel is used to apply mortar. Then the first block is laid down and stabilized with a hammer. A spirit level is used for levelling and facing with previously erected blocks.

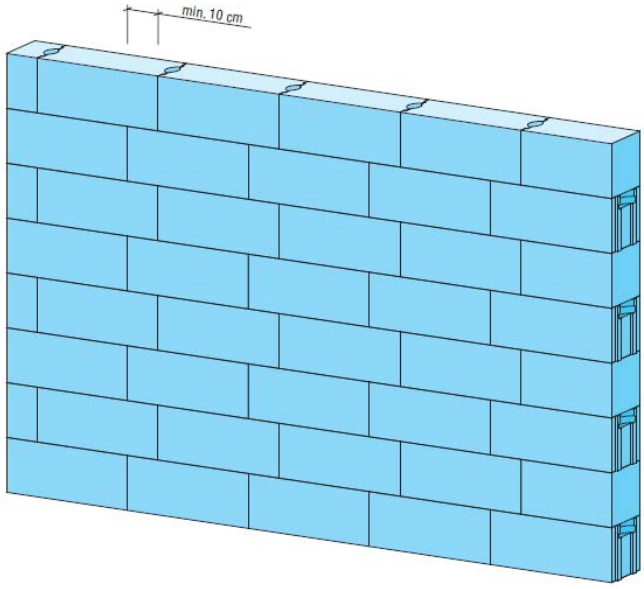
Picture 27: Application of a thin-layer mortar.

The first block should be laid in order to keep the tongues out. Later it will be easy to grid them and the only space to be filled in will be the hand grip.

Picture 28: Laying down the first block (N.B. tongues are ground down).

When both blocks form a corner there is no system of tongues and grooves. Therefore, the mortar should be applied on the second block. This is a rule which must be always observed: non-profiled areas of blocks must be coupled with mortar.

One should consider the correct location of blocks. Head joints must be displayed at least 10 cm in relation to each other.



Picture 29: Correct location of blocks.

Tip: Tongues of corner blocks projecting beyond the plane of a façade should be ground down after the erection of a few layers, when they are still accessible. Late grinding requires the movement of scaffolding or use of a ladder. Some contractors grind the tongues of a block before laying it.

Projecting tongues must not be left for the plastering team as they may not have the appropriate finishing trowel.

When corners are already erected, a rope is placed between them. Now, other blocks may be laid. This is a job that is carried out quickly and easily. Using a trowel, mortar is applied and then the block is laid down. The block must always be stabilized with a rubber hammer and its alignment must be controlled with a spirit level. The same procedure is repeated for each subsequent block.

Usually, the last block must be cut to size. The procedure is the same as for the first layer. The empty space is measured, the block is cut to the dimensions and tongues are cut off. Mortar is applied on the cut side of the block, which is inserted into the space. The entire layer is built within a few minutes.

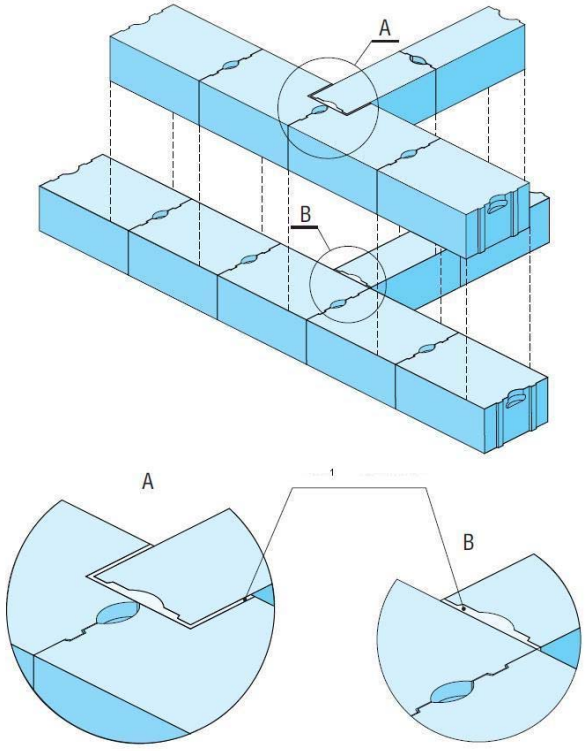
Coupling of an external wall and internal wall

When building external walls there are points where they touch internal carrying walls. The following principles must be observed to ensure both are built correctly.

Previously, when building the first layer, the first block of internal wall was inserted at this point. With subsequent layers it is necessary to carry out a masonry location. The correct procedure is described below:

At the beginning, the block to be laid into the external wall must be cut in such a way as to leave a space in the wall which is 15 cm deep. This can be carried out with a manual saw or a band-saw. A block of internal carrying wall should be laid in the space. Since there is no shaping on the contact area of blocks, the adhesive mortar must be applied on the block to be inserted. This will fix both elements.

The depth and location of the space is very important. 15 cm of space does not cause a thermal bridge at the contact point of walls.



1. Mortar in vertical joint.

Picture 30: Correct re-laying of wall's elements.

Picture 31: Coupling of an external wall and internal carrying wall.

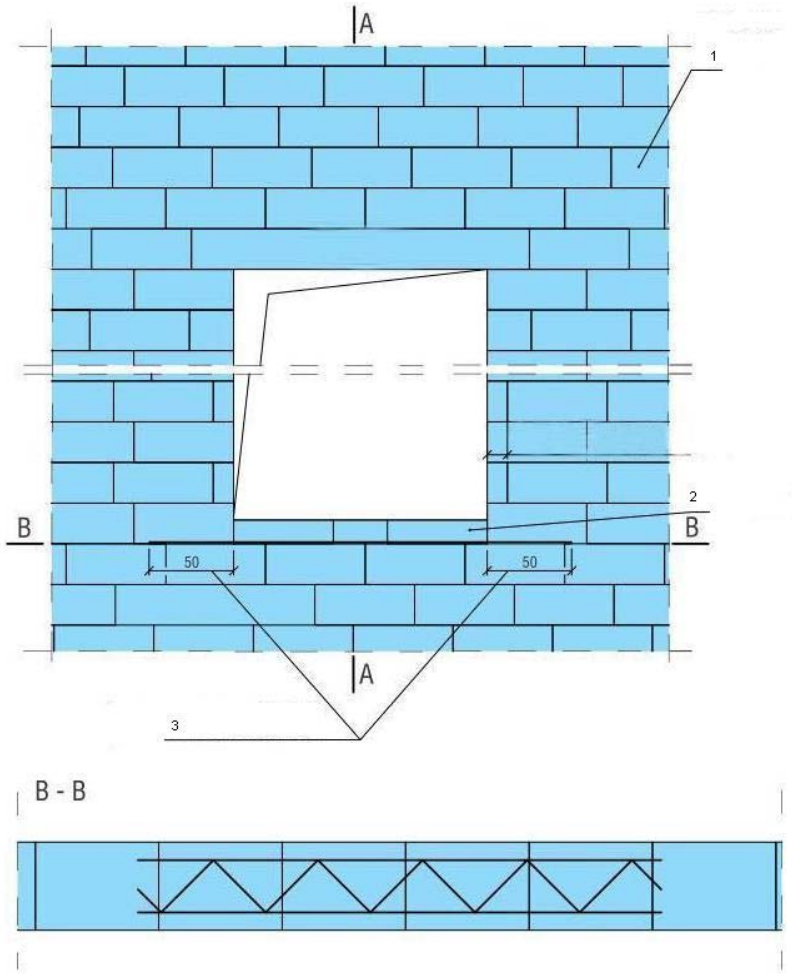
Erection at holes

When laying subsequent layers they will include layers with window holes. These are important points in the structure of each building because of the distribution of strengths and tensions. They may cause scratches of the wall under windows. This is an issue which concerns every building, no matter what type of material it is built of.

Picture 32: Rearming part of a wall under a windowsill with reinforcement.

Picture 33: In the last joint under a window reinforcement is placed.

In order to avoid such a situation, the proposed solution consists of strengthening the under-window zone with use a special reinforcement. This reinforcement is in the form of a flat framework made of galvanized bars, or steel with epoxide coat, or stainless steel. Each particular type of reinforcement used depends on the environment. The reinforcement is set into a layer of mortar under blocks in the lowest layer under the window. The length of the reinforcement must exceed the width of the window by at least 100 cm. That means that for each window hole at least 50 cm needs to be added to anchor the Mufor reinforcement properly. Reinforcement is placed in a layer of thin layer mortar. The last layer of blocks is placed on a joint reinforced in this way.



1. Covering of the ring with cellular concrete tiles.
2. Blocks adjusted to under-window zone.
3. Range of reinforcement bar.

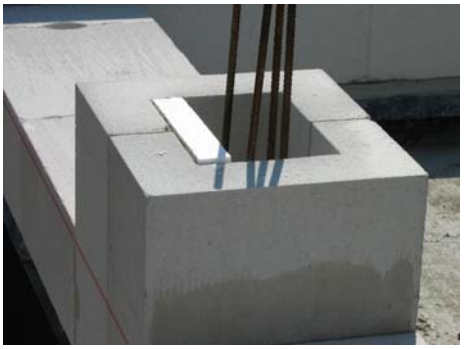
Picture 34: Manner of reinforcing the under-window zone.

Another potential trouble spot can be a door hole or the end of a wall. The length of ending block, i.e. the one situated at the edge of a wall must amount to at least 12 cm. The orientation of tongues and grooves must also be considered. It is advisable to situate the last block in such manner that makes it unnecessary to supplement its surface at the localizations of the grooves.

Other elements of a wall

Some fragments of walls must be reinforced from time to time. The most frequent type of reinforcement is with reinforced-concrete poles situated in walls. Their location must accurately designed and marked up in the plans. Any data regarding the dimensions, type and location of the reinforcement must be provided.

Such pillars can be made of U profiles. In this case the profiles provide a stay-in-place formwork for the reinforced concrete pole. This is a simple solution which is easy to carry out. Moreover, after erection, the profiles face with the blocks in a wall and create a uniform area of wall.



Picture 35: U profiles used to place a reinforced concrete pole.

A reinforced concrete pole in wall a must be anchored with a foundation. Consequently, anchoring reinforcement must be fastened.

Profiles must be erected with using a thin-layer mortar. Two profiles should be coupled by metal couplers - which are also used to fix partition walls.

As the pole's stud will be made of reinforced concrete which provides a thermal bridge, the shuttering must be filled with insulation. Non-absorbent wool or foamed polystyrene, at least 5 cm thick, must be used. Insulation should be located inside a shuttering from the external wall's side.

Tip: In case the insulation is poured with concrete, moisture-resistant products must be used, for example, non-absorbent mineral wool or foamed polystyrene.

In order to decrease the absorption of water from the concrete mixture by U profiles, using water to moisten the shuttering is recommended. This can be done before or after insertion of the reinforcement.

The last operation is pouring the concrete mixture. The concrete mixture must be condensed and de-aerated. A bar may be used.

Lintels – important elements of a building

Use of prefabricated lintels reinforced with carrying beams (e.g. made of cellular concrete) is simple.

Fastening this type of lintels is very simple. No cranes or lifts are required – just two-three men. Beams do not require a support during construction. The length of a lintel's support is important; in the case of short lintels (140 and 160 cm long) the support should equal 20 cm. In the case of longer lintels the support should be at least 25 cm.

When a lintel is fastened in a wall that is thicker than a single beam then it is necessary to join two or three lintels. Dimensions are chosen in such a manner that if inserting lintels side by side, the required width for each type of a wall is obtained.

Picture 36: Three lintels side by side – total width of a wall.

Other methods of building a lintel or reinforced-concrete beam requires the use of U profiles. In this case the U profiles provide so called stay-in-place formwork which means they constitute a building's structure. This method has a single advantage in relation to ready lintels: the U profiles enable erection of reinforced-concrete elements, which are much longer than pre-fabricates.

A lintel of U profile supports must be provided. The profiles are supported by pole-form supports, placed regularly across the entire width of a hole. Usually this is carried out with boards. When placing a support the level must be controlled. In some cases, when a span is large, the formwork must be provided with a "reversed arrow". This is achieved by rising the middle part of a formwork in relation to the part of the formwork at supports, to level subsequent beam bending.

Picture 37: Carrying out of lintels – U profiles.

A thin-layer mortar is applied on the U profile's side area. This is most easily done with the tiny trowel used for the erection of partition walls. Profiles must be stabilized with a rubber hammer.

Picture 38: Casting of the U profile formwork – to achieve a reinforced concrete beam.

Before the erection of the last profile, when the formwork is still open it must be dusted down. Then the last profile is erected and a layer of insulating material must be inserted into the formwork. A non-absorbent wool or foamed polystyrene, at least 5 cm thick, must be used. Insulation is laid from the outside.

Reinforcement must be placed in the formwork – made according to a design. The last stage is casting the formwork with the concrete mixture. In order to decrease the absorption of water by U profiles from the concrete mixture, moistening the shuttering with water is recommended. This may be done before or after insertion of the reinforcement.

The concrete mixture must be condensed and de-aerated using a poker vibrator or a bar. A prepared lintel will be resistant to total loading after 28 days of concrete stiffening. The supports should be taken down after 28 days.

Carrying out of a ring beam

The ring beam is a very significant part of a building. It holds together the entire structure –most frequently at ceiling level. When built improperly, it decreases thermal insulation parameters and impairs the quality of a building. As this is a reinforced concrete element one needs to take care to correctly place the ring's thermal insulation. Covering the ring with cellular concrete tiles and insulating this part of the building is a good solution.

Covering the ring with tiles should begin when formworks or ceilings are ready for casting. Tiles are laid down on the edges of walls. The height of the tiles must be adjusted to the height of a ceiling. If necessary the tiles must be cut.

Picture 39: Laying tiles on rings is a simple way of building a ring in a single-layer wall.

As the tiles' area is not profiled it is necessary to couple them with a vertical joint. They are erected using a thin-layer mortar applied with an appropriate trowel.

When all tiles are laid, a layer of insulating material is laid. This should be- non-absorbent mineral wool or foamed polystyrene which is at least 5 cm thick. Insulating material may be applied to tiles before or after reinforcing the ring.

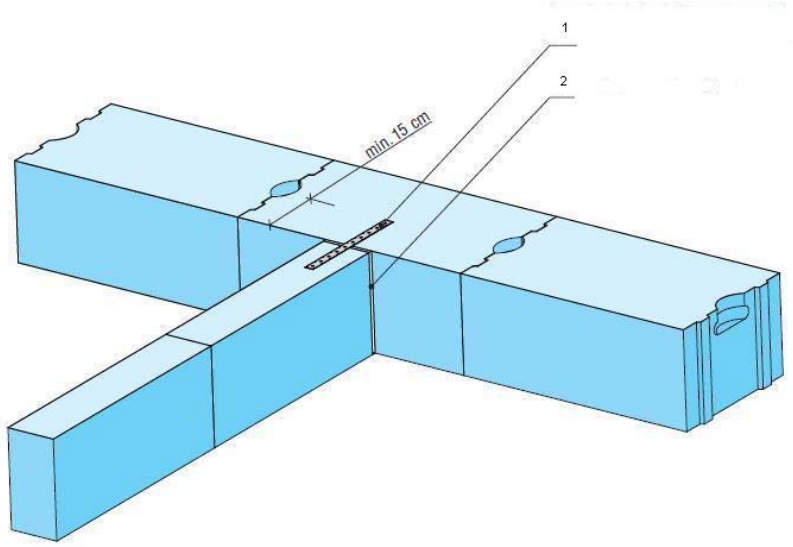
Picture 40: The ring with tiles must be cast with concrete.

The ring, built in such a manner and insulated does not cause a thermal bridge and it gives a uniform face to the wall, to which plaster will adhere well.

Another solution is a ring made of U profiles. This solution is mostly useful in buildings without a ceiling or in buildings where the ring is lower in relation to the ceiling.

Coupling of partition and carrying walls

At the contact point between carrying and partition walls one needs to use casual masonry location or metal couplers, which are inserted into a joint at the stage of a carrying wall erection. After insertion, the couplers may be bent and re-bent during erection of partition walls and inserted in a partition wall's joint.



1. Couplers in a partition wall's joint - every third blocks layer.
2. Mortar in vertical joint.

Picture 41: Correct coupling of a partition wall with external one.

Other stages of the erection process

Finishing works

The external area of the wall made of cellular concrete should be covered with a mineral plaster. This type of plaster is vapour-permeable and it greatly suits the cellular concrete which is also gas-permeable. Thickness of the external plaster may be up to 15 mm. The indoor walls can be finished with 10 mm thick gypsum plaster. Ceramic tiles may be directly applied to the walls, however, the surface should be ground first.

Picture 42: Plastering works on the even surface of a wall.

Multi-layer wall thermal insulation

There are many ways to insulate walls. Any insulating system may be applied. In this case, the manufacturer's recommendations should be observed. There is a method of fixing of the insulation layer with glue, but there are also methods which must be additionally pinned to the wall carrying layer due to special elements. The number of elements is accurately specified. Other elements of such systems can include slats, corner slats and other such method-appropriate accessories.

Conclusions

As shown, carrying out other parts of the building with these methods is not difficult. The use of materials with tongues and grooves and relying on a complete system enables a simple building process. Due to this system, processes carried out by bricklayers are easier and less demanding. Nevertheless, the aforementioned basic rules must be observed in order to save time and lower costs. Additionally, the qualities of some materials – e.g. cellular concrete – and other specially designed details provide a solid, durable, energy-consuming and safe building.

Chapter V TRAINING PART

An integral part of the module is the training section. It includes a three-day training cycle during which the following issues are subject to discussion:

Theoretical training (1 day)

- Wall parts and materials currently in use,
- Types of mortars
- Masonry tools
- Coupling of wall's elements
- Typical faults
- Permissible structure deviations
- Industrial health and safety introduction for bricklayers

Practical training (2 days)

- Workshops for two/three person teams.
- Individual performance of all tasks as directed by an instructor, including:

First day of workshops

- Wall bricklaying:
  - First layer (on s layer of foil and casual mortar)
  - Erection of other layers with consideration given to:
    - Correct re-erection of blocks.
    - Correct re-erection of walls.
    - Correct cutting of blocks.
    - Correct construction of a lintel.
    - Block cutting.
    - Correct use of appropriate tools.
    - Preparation, qualities and parameters of a mortar.
- Applying a layer of foamed polystyrene on a wall with using an adhesive and pins.

Second day of workshops:

- Re-erection of walls, angle different than 90 degrees.
- Half-round wall erection
- Applying adhesive grid on foamed polystyrene
- Application of selected plasters

Summary of workshops, FAQs, remarks and conclusions.

Test part

1. When erecting blocks with tongues and grooves, should one fill the head joint with a mortar?

a) Yes

b) No

2. May a ‘comb’ trowel be used to erect when using a thin joint?

a) Yes

b) No

3. Howe many blocks of dimensions: h: 24 x w.: 24 x l.: 59 cm are required to erect 1m^2 of wall?

a) 8.33

b) 10

c) 7

4. What simplifies masonry works?

a) Use of a system

b) Use of relevant tools

c) Erection using a thick joint

5. What is correct location of head joints in a wall?

a) 0.4h, where h means height of an element

b) at least 2 cm

6. Erection of the layer should start from:

a) The center of a wall

b) From a wall’s corners

7. The first layer of blocks erected on a foundation wall, should be laid using:

a) Casual mortar, having first applied a layer of horizontal insulation

b) Thin-layer mortar without horizontal insulation

8. Can thin-layer mortar be applied with a casual trowel?

a) No, as an even and thin layer will never be obtained

b) Yes

9. Is it correct to lay blocks with mortar placed on only a few points?

a) No

b) Yes

10. Is a circular saw blade necessary to cut cellular concrete blocks?

a) No. blocks may be cut with a manual saw

b) Yes, specialist tools are required

11. Does one need to fill hand grips with mortar?

a) No

b) Yes

12. When coupling partition walls and carrying walls with metal couplers, the couplers must be fixed into the joint:

a) in each layer

b) in every third layer of blocks

13. What is used to set out a straight line for erected wall?

a) A rope within a line of erected wall

b) Ruler

14. A spirit level is used to:

a) Measure a distance

b) Find levels

15. To stabilize and correctly align cellular concrete blocks one may use:

a) Construction hammer

b) Rubber face hammer

USEFUL SOURCES:

- Polish Construction Law
- Norm PN-B-03002 Masonry construction. Design and detailing.
- GUIDANCE IN TRADES - edition II – Ministry of Labour and Social Policy; Warsaw 2003

Links:

www.ciop.pl
www.portalbhp.pl
www.infor.pl
www.solbet.pl